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NATIONAL DAM INSPECTION PROGRAM. INGHAM CREEK (AQUETONG LAKE)

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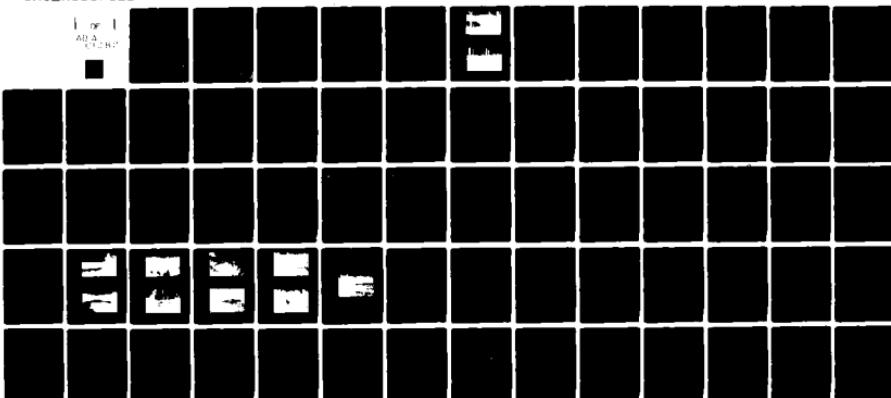
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INGHAM CREEK
PENNSYLVANIA

NDI ID PA 00224
PA DER 9-49

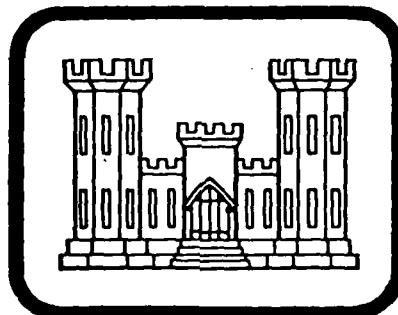
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LEVEL IV

INGHAM CREEK (AQUETONG LAKE) DAM

OWNED BY
DR. KENNETH JUDY

PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM



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DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS

BALTIMORE, MARYLAND
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National Dam Inspection Program. Ingham Creek (Aquetong Lake) Dam (NDI ID PA 00224, PA DER 9-49) Delaware River Basin, Ingham Creek, Pennsylvania. Phase I Inspection

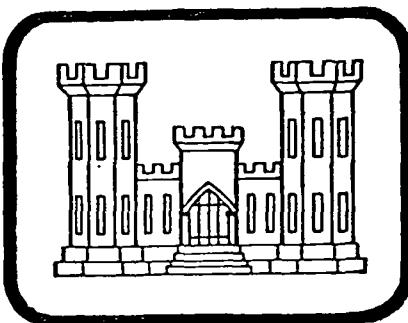
DELAWARE RIVER BASIN

INGHAM CREEK DAM
PENNSYLVANIA

NDI ID PA 00224

OWNED BY
DR. KENNETH JUDY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



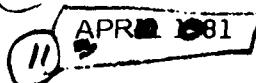
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Prepared by:

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Ingham Creek (Aquetong Lake) Dam
State Located: Pennsylvania
County Located: Bucks
Stream: Ingham Creek
Coordinates: Latitude N 40°21.3', Longitude W 74°59.4'
Date of Inspection: December 18, 1980

ASSESSMENT

Ingham Creek Dam, which impounds a private recreational lake, consists of an earth embankment approximately 645 feet long with a maximum height of 24 feet. The embankment has a variable top width averaging about 13 feet, a downstream slope averaging about 1.5H:1V and an unknown upstream slope below the water surface. The dam impounds a reservoir with a normal pool surface area of 12.4 acres and a storage capacity of 93 acre-feet. The spillway, located about 95 feet from the left abutment, consists of a rockfill covered with a concrete slab. It is 25 feet long at the crest, 21 feet long at the downstream end, and 25 feet wide. The spillway crest (Elev. 149.8) is one foot below the concrete spillway sidewalls. A wooden sluiceway structure with stoplogs, which is located about 50 feet left of the spillway sidewall, is 5 feet wide by 3 feet deep. It was once used to direct water to a mill downstream of the dam and is now in poor condition.

The spillway Design Flood (SDF) chosen for this "Small" size, "Significant" hazard dam is the 100 year flood. The spillway is capable of discharging approximately 17 percent of the SDF prior to overtopping the low point of the top of the dam; therefore, it is classified as "Inadequate".

Based on the visual observations, discussions with the Owner, Dr. Kenneth Judy, and information obtained from the Pennsylvania Department of Environmental Resources, Division of Dam Safety, Ingham Creek Dam is considered to be in fair condition.

Recommendations and Remedial Measures are as follows:

The following recommendations and remedial measures should be initiated immediately. The Owner should retain the services of a licensed professional engineer experienced in the design and construction of dams to assist in complying with these recommendations and remedial measures.

a. Facilities.

1. The capacity of the spillway should be increased to provide safe passage of the SDF.

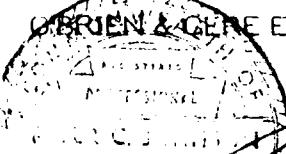
2. An investigation should be made of the source and nature of the seepage observed at the downstream toe of the embankment.

INGHAM CREEK (AQUINTONG LAKE) DAM
NDI PA 00224
PA DER 9-49

3. The embankment should be cleared of all trees and brush and any resulting voids should be backfilled with a suitable compacted material. A grass cover should be established and maintained on the reconstructed slopes and crest of the dam.
4. The spillway discharge channel should be improved.
5. Provision should be made for reservoir drawdown.
6. The hole adjacent to the right spillway sidewall should be backfilled.
7. Riprap should be replaced where needed on the upstream face of the embankment to protect against wave action.
8. The wooden sluiceway structure should be rehabilitated or removed.

b. Operation and Maintenance Procedures

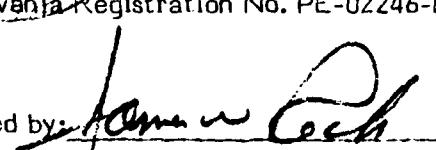
1. A regular inspection and maintenance program should be developed and implemented.
2. A system for warning downstream residents in the event of an impending dam failure should be developed.

 O'BRIEN & GERÉ ENGINEERS, INC.

Peter C. Johnson, P.E.
Senior Vice President
Pennsylvania Registration No. PE-02246-E

Date: 29 April 81

Approved by:


JAMES W. PECK, Colonel
Corps of Engineers
District Engineer

Date: 22 May 81



UPSTREAM OVERVIEW FROM THE RIGHT ABUTMENT. (12/19/81)



DOWNSTREAM OVERVIEW FROM THE RIGHT ABUTMENT. (12/19/81)

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
INGHAM CREEK DAM NDI ID PA00224
PA DER 9-49

SECTION I

PROJECT INFORMATION

1.1 General

a. Authority. The dam inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if Ingham Creek Dam constitutes a hazard to human life or property.

1.2 Description of Project (Based upon information obtained from the Pennsylvania Department of Environmental Resources (DER), Division of Dam Safety, Harrisburg, Pennsylvania, and this inspection.)

a. Dam and Appurtenances. Ingham Creek Dam consists of an earth embankment, approximately 645 feet long, with a maximum height of 24 feet. The embankment has a variable top width averaging about 13 feet, a downstream slope averaging about 1.5H:1V and an unknown upstream slope below the water surface. Intermittent riprap was noted on the visible portion of the upstream slope. The dam impounds a normal pool with a surface area of 12.4 acres and a storage capacity of 93 acre-feet.

The spillway, located about 95 feet from the left abutment, consists of a rock fill covered with a concrete slab. It is 25 feet long at the crest, 21 feet long at the down stream end and 25 feet wide. The spillway crest (El. 149.8) is one foot below the concrete spillway sidewalls. The spillway discharge channel, which is ill defined and cluttered with debris, averages about 15 feet in width with side slopes approximating 2H:1V.

A wooden sluiceway structure with stoplogs, which is located about 50 feet left of the left spillway sidewall, is 5 feet wide by 3 feet deep. The sluiceway was once used to direct water to a mill downstream of the dam; however, it is now in disrepair with no definable discharge channel.

b. Location. Ingham Creek Dam is located on Ingham Creek in Solebury Township, Pennsylvania, approximately two miles west of New Hope, south of Route 202. The dam site is shown on the USGS quadrangle entitled "Lambertville, PA-NJ", at coordinates N 40°21.3', W 75°59.4'. A regional location plan of Ingham Creek Dam is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam has a maximum height of 24 feet and a maximum storage capacity of 105 acre-feet. This places Ingham Creek Dam in the "Small" size category because it is less than 40 feet high and has a maximum storage capacity of less than 1,000 acre-feet.

d. Hazard Classification. One private residence, located approximately 1.5 miles downstream of the dam and about 5 feet above the channel bed, would probably experience appreciable damage in the event of a dam failure, but the chances for loss of life would be limited. Ingham Creek Dam is therefore, classified as a "Significant" hazard structure.

e. Ownership. Ingham Creek Dam is owned by Dr. Kenneth Judy, 1 Lower Mountain Road, New Hope, Pennsylvania, 18938. Phone: (215) 862-9385.

f. Purpose of the Dam. The impoundment is used for private recreational purposes.

g. Design and Construction History. The dam was constructed in the late 1800's to supply water power to a mill immediately downstream of the dam. No records are available relative to the design or construction of Ingham Creek Dam.

h. Normal Operating Procedures. No operating procedures exist for this dam.

1.3 Pertinent Data

a. Drainage Area.

| | |
|--------------|------|
| Square Miles | 0.39 |
|--------------|------|

b. Discharge at Dam Site (cfs).

| | |
|---|----|
| Maximum Spillway Discharge (Reservoir at low point of crest of dam. Elev. 150.8) | 80 |
|---|----|

e. Elevation (Feet above MSL)*

| | |
|---|-------|
| Spillway Crest (normal pool) | 149.8 |
| Top of Dam (low point) | 150.8 |
| Invert of Wooden Sluiceway Structure (Blocked by debris and embankment material) | 148.4 |
| Downstream Toe | 126.8 |

d. Reservoir (Feet)

| | |
|--|-------|
| Length of Normal Pool | 1,400 |
| Length of Maximum Non-Overtopping Pool | 1,450 |

*Reservoir water surface elevation at the time of the inspection was estimated from the USGS quad map to be 150.0 feet above MSL. All elevations are based on this datum.

| | | |
|-----------|--|--|
| e. | <u>Storage (Acre-Feet)</u> | |
| | Normal Pool, Elev. 149.8 | 93 |
| | Top of Dam, Elev. 150.8 | 105 |
| f. | <u>Reservoir Surface Area (Acres)</u> | |
| | Normal Pool, Elev. 149.8 | 12.4 |
| | Top of Dam, Elev. 150.8 | 13.4 |
| g. | <u>Dam Data</u> | |
| | Type | Earth Embankment |
| | Length | 645 feet |
| | Height to Low Point of Top of Dam | 24 feet |
| | Crest Width | ±13 feet |
| | Side Slopes | |
| | Upstream | Unknown |
| | Downstream | 1.5H:1V |
| | Zoning | Unknown |
| | Impervious Core | Unknown |
| | Cutoff | Unknown |
| | Grout Curtain | Unknown |
| h. | <u>Spillway</u> | |
| | Type | Concrete slab over rock |
| | Length | |
| | At crest | 25 feet |
| | Downstream end | 21 feet |
| | Width | 25 feet |
| | Crest Elevation | 149.8 |
| | Discharge Channel | Poorly defined, littered with debris, 15' wide, slopes 2H:1V |
| i. | <u>Outlet Works</u> | |
| | Type | Wood sluiceway with stoplogs blocked with debris and embankment material |
| | Width | 5 feet |
| | Depth | 3 feet |

SECTION 2
ENGINEERING DATA

2.1 Design

- a. Data Available. No design data is available for the dam.
- b. Design Features. The design features are described in Section 1.2a and shown on the sheets in Appendix E.

2.2 Construction

No information is available relative to the construction of the dam.

2.3 Operation.

No operational procedures exist for the dam.

2.4 Evaluation

- a. Availability. The limited engineering data utilized in this report was provided by the Pennsylvania DER.
- b. Adequacy. The information provided by the Pennsylvania DER, visual observations and discussions with Dr. Judy, the owner, are considered adequate for a Phase I investigation.
- c. Validity. There appears to be no reason to question the validity of the information obtained from the Pennsylvania DER and Dr. Judy.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Ingham Creek Dam took place on December 18, 1980. At the time of the inspection, the water surface was approximately 0.2 feet above the spillway crest. The observations and comments of the field inspection team are in the checklist which is Appendix A of this report. The dam and its appurtenances appear to be marginally maintained.

b. Dam. Many large trees (up to 18-inch diameter trunks and 40 feet high) and brush are growing on the top of the embankment and on the downstream face. The freeboard averages about one foot and riprap is intermittent on the exposed portion of the upstream face. An approximately 2-foot deep hole was observed in the embankment adjacent to the right spillway sidewall. Considerable seepage (5 gpm) was observed at the downstream toe of the embankment between 100 and 200 feet from the south end of the dam. The ground in this area is very soft and swampy. No fines were apparent in the seepage water.

c. Appurtenant Structures. The spillway, which consists of a concrete cap over rock, appears to be in fair condition. The spillway sidewalls extend only one foot above the spillway floor. The erosion adjacent to the right spillway sidewall may indicate that the spillway sidewalls were overtopped at one time. The discharge channel for the spillway, which is poorly defined and filled with debris, is approximately 15 feet wide with side slopes approximating 2H:1V.

The wooden sluiceway, which is blocked with debris and earth material, is in poor condition with no definable outlet.

d. Reservoir. The degree of sedimentation in the reservoir was difficult to estimate from visual observations. Dr. Judy mentioned that construction upstream of the lake has contributed to sedimentation buildup. Area reconnaissance disclosed no evidence of slope instability. The slopes along the perimeter of the reservoir are steep to the south and mild on the north and west sides. The entire perimeter is covered with trees.

e. Downstream Channel. The existing discharge channel for the first few hundred feet downstream of the dam is obstructed with fallen trees and debris. Beyond this reach, the channel is relatively free of obstructions as it flows through pasture land on an average grade of approximately 1 percent.

Only one private residence was found downstream of the dam which would be affected by a failure of the dam. It is situated about 5 feet above the channel water surface, approximately 1.5 miles from Ingham Creek Dam.

3.2 Evaluation

The limited freeboard to the low point of the dam severely limits the spillway capacity. Lack of riprap on the upstream face could lead to erosion of the upstream face of the embankment. Bushes and trees growing on the crest and downstream face create potential seepage paths through the embankment and may endanger the integrity of the structure. The seepage at the downstream toe of the dam may indicate that piping is occurring through the embankment and/or the foundation of the dam. The spillway discharge channel, which is poorly defined and filled with debris, is inadequate. The general condition of the dam is fair.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures

No operational procedures for this dam exist. However, many years ago, water was diverted to a mill immediately downstream of the dam through the wooden sluiceway by adjusting the stoplogs in the sluiceway.

4.2 Maintenance of the Dam

No maintenance procedures exist for the dam. According to the Owner, Dr. Judy, the property caretaker, John Brillman, does work on the dam when needed.

4.3 Maintenance of Operating Facilities

No operating facilities exist at the dam.

4.4 Description of Any Warning Systems in Effect

According to the Owner, no written warning procedures exist for Ingham Creek Dam. The dam is monitored during large storms by the property caretaker, John Brillman. In the event of a dam failure, Mr. Brillman would notify the Solesbury Police Department.

4.5 Evaluation

The large trees and brush on the dam and the debris clogging spillway discharge channel and the other items mentioned above indicate that the dam is not adequately maintained. A regular inspection and maintenance program should be established which would include removing of all trees and brush on the embankment and maintaining a suitable grass cover and clearing all obstructions from the spillway discharge channel.

A system of warning downstream residents in the event of an impending dam failure should be developed.

SECTION 5

HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Ingham Creek Dam has a drainage area of 0.39 square miles and impounds a reservoir with a normal pool storage capacity of 93 acre-feet. The watershed has a maximum width of about 0.95 miles and a maximum length of about 0.70 miles. The ground surface ranges from Elev. 320 in the upper reaches of the watershed to Elev. 149.8 at normal pool. The drainage area is generally moderately sloping woodland.

The spillway consists of a rock fill covered with a concrete slab. It is 25 feet long at the crest, 21 feet long at the downstream end and 25 feet wide. The spillway crest (Elev. 149.8) is one foot below the top of the concrete spillway sidewalls. The spillway has a capacity with the reservoir pool at the top of the dam (low point Elev. 150.8) of 75 cfs.

The 5-foot wide by 3-foot deep wooden sluiceway, which is currently obstructed with debris and earth material, was not considered in the analysis because it would have little effect as a reservoir drainage facility.

b. Experience Data. According to the Owner, no rainfall or reservoir level records are kept for this dam.

c. Visual Observation. The capacity of the spillway is limited by the spillway sidewalls and the low point of the top of the dam which are both only one foot above the spillway crest. Discharge is impeded by the fallen trees and debris in the spillway discharge channel.

d. Overtopping Potential. The overtopping potential of this dam was estimated using the HEC-1, Dam Safety Version, computer program. A brief description of the program is included in Appendix D.

According to the Guidelines, the recommended Spillway Design Flood (SDF) for a "Small" size, "Significant" hazard dam ranges from the 100 year flood to one-half of the Probable Maximum Flood (PMF). The SDF selected for the analysis of Ingham Creek Dam is the 100 year flood because of the potential for the appreciable damage to only one house at the damage center in the event of a dam failure. The chance for the loss of human life in the event of a dam failure is limited.

The 100 year flood was routed through Ingham Creek Dam using the HEC-1 computer program. The peak inflow and outflow rates for the SDF were both computed to be about 470 cfs. Based on the hydrologic and hydraulic analysis, the spillway is capable of discharging 17 percent of the SDF without overtopping the low point of the crest of the embankment (See Appendix D for computations). The SDF would overtop the dam by a maximum of about 0.2 feet and the duration of overtopping would be 2.8 hours.

e. Spillway Adequacy. The Ingham Creek Dam spillway is classified as "Inadequate".

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. Many large trees and brush are growing on the top and on the downstream face of the embankment. Only about one foot of freeboard exists and riprap is missing in places on the upstream face. A hole approximately 2 feet deep exists in the embankment, adjacent to the right spillway abutment. Seepage was observed (5 gpm) at the downstream toe of the embankment, between 100 and 200 feet from the south abutment. The ground in this area is very soft and swampy. No fines are apparent in the seepage discharge.

Based on visual observations, the embankment appears to be stable under static loading conditions. An investigation should be made, however, as to the source and nature of the seepage and appropriate actions should follow.

b. Design and Construction Data. No design or construction data is available for this dam.

c. Operating Records. According to the Owner, no operating records are maintained for this dam.

d. Post Construction Changes. No records are available for any structural changes to the dam subsequent to the completion of construction.

e. Seismic Stability. Ingham Creek Dam is located in Seismic Zone 1 on the Seismic Zone Map of Contiguous States. A dam located in Seismic Zone 1 is generally considered to be safe under any expected Zone 1 earthquake loading conditions if it is stable under static loading conditions.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Evaluation. Based on the visual observations and review of the available information, Ingham Creek Dam is considered to be in fair condition. Several deficiencies were noted during the inspection.

Many large trees and brush are growing over the entire embankment. The freeboard averages only about one foot and riprap is intermittent on the upstream face of the dam. Clear seepage was observed (5 gpm) at the downstream toe of the embankment between 100 and 200 feet from the southern abutment. The ground in this area is very soft and swampy. The spillway appears to be in satisfactory structural condition; however, the spillway sidewalls extend only one foot above the spillway crest. A hole approximately 2 feet deep is located adjacent to the right spillway sidewall which indicates that the embankment was probably overtopped at one time, but no records are available to verify this. The existing spillway discharge channel is obstructed with fallen trees and debris. The wooden sluiceway, which is clogged with debris and embankment material, is in poor condition.

The SDF selected for Ingham Creek Dam is the 100 year flood. The spillway is capable of discharging about 17 percent of the SDF before the embankment is overtopped; therefore, it is classified as "Inadequate", since the spillway cannot pass the SDF.

b. Adequacy of Information. The information obtained from DER, visual observations and discussions with Dr. Judy, the Owner, are considered adequate for a Phase I investigation.

c. Urgency. The remedial measures recommended in Section 7.2 should be initiated immediately.

d. Necessity for Further Information. Further investigation should be implemented as discussed in Section 7.2.

7.2 Recommendations and Remedial Measures

The following recommendations and remedial measures should be initiated immediately. The Owner should retain the services of a licensed professional engineer experienced in the design and construction of dams to assist in complying with these recommendations and remedial measures.

a. Facilities.

1. The capacity of the spillway should be increased.
2. An investigation should be made of the source and nature of the seepage observed at the downstream toe of the embankment.

3. The embankment should be cleared of all trees and brush and any resulting voids should be backfilled with a suitable compacted material. A grass cover should be established and maintained on the reconstructed slopes and crest of the dam.

4. The spillway discharge channel should be improved.
5. Provision should be made for reservoir drawdown.
6. The hole adjacent to the right spillway sidewall should be backfilled.
7. Riprap should be replaced where needed on the upstream face of the embankment to protect against wave action.
8. The wooden sluiceway structure should be rehabilitated or removed.

b. Operation and Maintenance Procedures

1. A regular inspection and maintenance program should be developed and implemented.
2. A system of warning downstream residents in the event of an impending dam failure should be developed.

APPENDIX A
CHECKLIST
VISUAL INSPECTION

CHECK LIST
VISUAL INSPECTION
PHASE I

Sheet 1 of 11

| | | | | | | |
|--------------------|-------------------------|-----------------|--------------------|-------------|---------------------|----------|
| Name Dam | <u>Ingham Creek Dam</u> | County | <u>Bucks</u> | State | <u>Pennsylvania</u> | National |
| Type of Dam | <u>Earth Embankment</u> | Hazard Category | <u>Significant</u> | ID # | <u>PA-002224</u> | |
| Date(s) Inspection | <u>12/18/80</u> | Weather | <u>Cloudy</u> | Temperature | <u>250F</u> | |

Pool Elevation at Time of Inspection 150 + M.S.L. Tailwater at Time of Inspection - M.S.L.

Inspection Personnel:

| | | |
|------------------------|---------------------|---------------------------|
| <u>Leonard R. Beck</u> | <u>Richard Beck</u> | <u>John F. Rauschkolb</u> |
| | <u>Lee DeHeer</u> | |
| | | |
| | | |

Leonard R. Beck Recorder

Remarks:

Dr. Judy, the owner (phone: 215-862-9385), was on site and provided information to the inspection team.

CONCRETE/MASONRY DAMS

Sheet 2 of 11

| <u>VISUAL EXAMINATION OF</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|------------------------------|---------------------|-----------------------------------|
| ANY NOTICEABLE SEEPAGE | N/A | |

| | | |
|--|-----|--|
| STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS | N/A | |
|--|-----|--|

| | | |
|--------|-----|--|
| DRAINS | N/A | |
|--------|-----|--|

| | | |
|----------------|-----|--|
| WATER PASSAGES | N/A | |
|----------------|-----|--|

| | | |
|------------|-----|--|
| FOUNDATION | N/A | |
|------------|-----|--|

CONCRETE/MASONRY DAMS

| Sheet 3 of 11 | | |
|--------------------------------------|--------------|----------------------------|
| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
| SURFACE CRACKS CONCRETE SURFACES | N/A | |
| STRUCTURAL CRACKING | N/A | |
| VERTICAL AND HORIZONTAL ALIGNMENT | N/A | |
| MONOLITH JOINTS | N/A | |
| CONSTRUCTION JOINTS | N/A | |

| VISUAL EXAMINATION OF <u>EMBANKMENT</u> | | Sheet 4 of 11 | REMARKS OR RECOMMENDATIONS |
|--|---|-------------------------|----------------------------|
| | OBSERVATIONS | | |
| SURFACE CRACKS | None observed. | | |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE | None observed. | | |
| SLoughing OR Erosion OF EMBANKMENT AND ABUTMENT SLOPES | None observed. | | |
| VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST | Horizontal alignment is straight. Vertical alignment varies from Elev. 152.2 to Elev. 150.8 See sheet 11B of 11. | | |
| RIPRAP FAILURES | Riprap is missing in spots on the upstream face of the embankment. | Replace missing riprap. | |

EMBANKMENT

| <u>VISUAL EXAMINATION OF</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|---|--|---|
| VEGETATION | Many large trees are growing on the top of the dam and on the downstream embankment slope. | Trees should be removed and grass should be planted and maintained on the embankment. |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | A 2-foot deep hole was observed in the embankment adjacent to the right spillway abutment. The spillway abutment may have been overtopped at one time. | The hole should be filled in with a suitable material compacted. |
| ANY NOTICEABLE SEEPAGE | Considerable seepage (5gpm) was observed at the downstream toe of the embankment. The ground in this area below the dam is soft and swampy. | Investigate the source and extent of the seepage. |
| STAFF GAGE AND RECORDER | None. | |
| DRAINS | None. | |

OUTLET WORKS

Sheet 6 of 11

| <u>VISUAL EXAMINATION OF</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|--|---------------------|-----------------------------------|
| CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT | N/A | |

INTAKE STRUCTURE

N/A

OUTLET STRUCTURE

N/A

OUTLET CHANNEL

N/A

EMERGENCY GATE

N/A

Sheet 6 of 11

UNIGATED SPILLWAY

| VISUAL EXAMINATION OF | | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|-----------------------|--|---|---|
| CONCRETE WEIR | | Concrete slab, 25-ft long, 25-ft wide at the upstream end, and 21-ft wide at the downstream end which is about 3-ft. above the outlet channel. The abutments extend only 1ft. above the spillway crest. | |
| APPROACH CHANNEL | | The reservoir. | |
| DISCHARGE CHANNEL | | No improved discharge channel was constructed. The existing channel which is obstructed with fallen trees and debris is 15' wide with slopes of approximately 2H:IV. | Channel should be cleared and maintained to facilitate discharge. |
| BRIDGE AND PIERS | | | N/A |

GATED SPILLWAY

Sheet 8 of 11

| <u>VISUAL EXAMINATION OF</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|-------------------------------|---------------------|-----------------------------------|
| CONCRETE SILL | N/A | |
| APPROACH CHANNEL | N/A | |
| DISCHARGE CHANNEL | N/A | |
| BRIDGE AND PIERS | N/A | |
| GATES AND OPERATION EQUIPMENT | N/A | |

INSTRUMENTATION

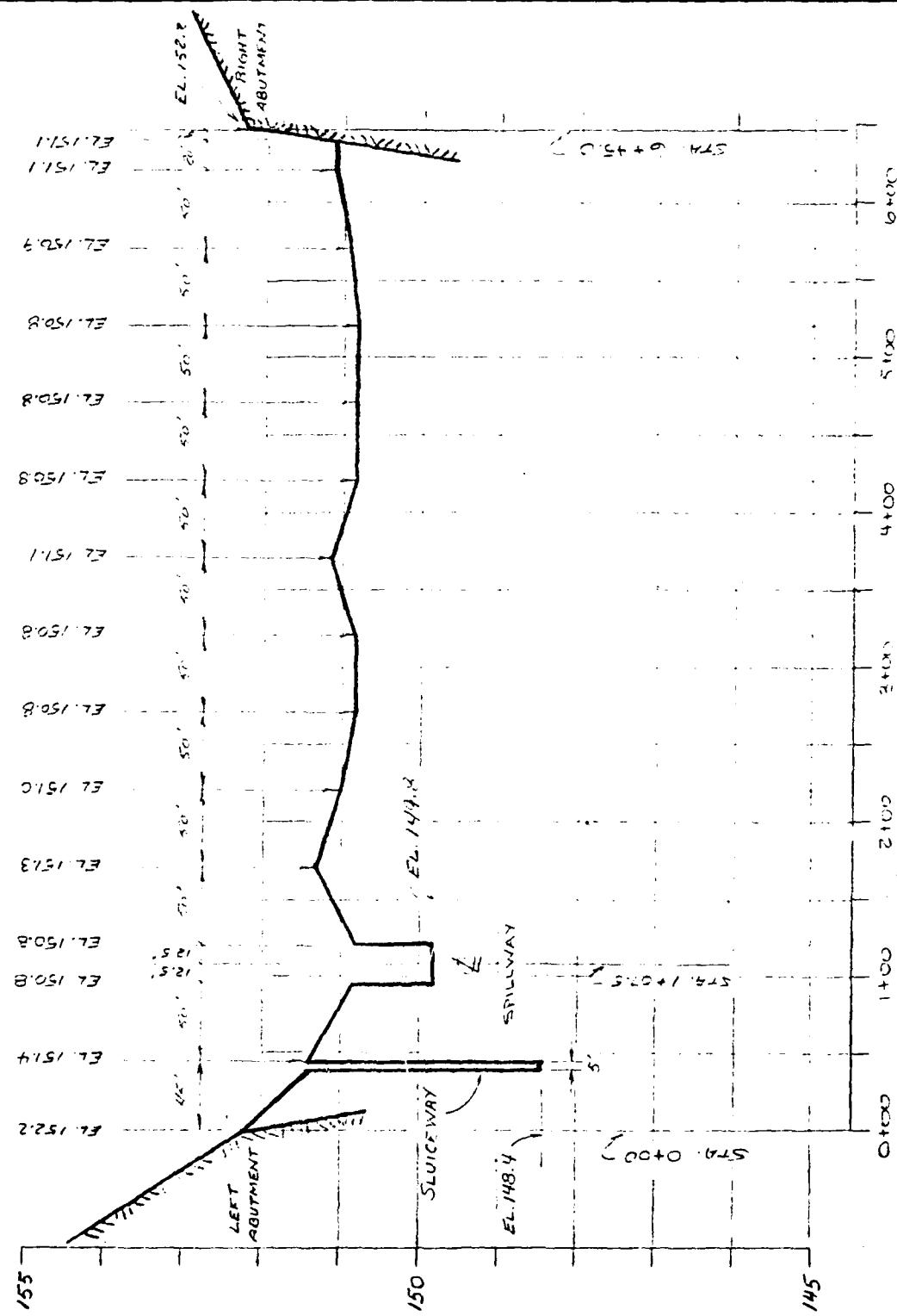
| | <u>VISUAL EXAMINATION</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|------------------------------|---------------------------|---------------------|-----------------------------------|
| <u>MONUMENTATION/SURVEYS</u> | | None | |
| <u>OBSERVATION WELLS</u> | | None | |
| <u>WEIRS</u> | | None | |
| <u>PIEZOMETERS</u> | | None | |
| <u>OTHER</u> | | N/A | |

| VISUAL EXAMINATION OF | | Sheet 10 of 11 | REMARKS OR RECOMMENDATIONS |
|-----------------------|---|--|----------------------------|
| RESERVOIR | OBSERVATIONS | | |
| SLOPES | Reservoir side slope is steep on right side and mild on left side and upstream. Trees are growing to the water's edge on the entire perimeter of the reservoir. | | |
| SEDIMENTATION | | It was difficult to tell how much sediment is in the reservoir; however, the Owner, Dr. Judy mentioned that construction upstream of the reservoir has contributed to sedimentation. | |

DOWNSTREAM CHANNEL

| VISUAL EXAMINATION OF | | | Sheet 11 of 11 | |
|---|---|----------------------------|----------------|--|
| CONDITION (OBSTRUCTIONS, DEBRIS, ETC.) | OBSERVATIONS | REMARKS OR RECOMMENDATIONS | | |
| | The existing discharge channel for the first few hundred feet downstream of the dam is obstructed with fallen trees and debris. Beyond this reach, the downstream channel is relatively free of obstructions. | | | |
| SLOPES | Channel grade average 0.008 ft/ft | | | |
| APPROXIMATE NO. OF HOMES AND POPULATION | Only one residence about 1.5 miles downstream was found to be in a potentially hazardous location. It's low sill is situated about 5 feet above the channel water surface. | | | |

| | | | | | | | | | |
|---------|------------|-------|-----|----|-----|------|----------|--------|----------|
| SUBJECT | INGHAM DAM | SHEET | 118 | BY | JFK | DATE | 11/28/31 | JOB NO | 1841-614 |
|---------|------------|-------|-----|----|-----|------|----------|--------|----------|



PROFILE ALONG THE Ⓛ OF THE DAM LOOKING DOWNSTREAM

APPENDIX B
CHECKLIST
ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Ingham Creek Dam
ID # PA 00224

Sheet 1 of 4

ITEM
AS-BUILT DRAWINGS
REMARKS
None Exist

REGIONAL VICINITY MAP
Refer to plate 1, Appendix E

CONSTRUCTION HISTORY
Not Available

TYPICAL SECTIONS OF DAM
Refer to Appendix E

OUTLETS - PLAIN
DETAILS
CONSTRAINTS
DISCHARGE RATINGS
RAINFALL/RESERVOIR RECORDS
Refer to Appendix D
None

Sheet 2 of 4

| ITEM | REMARKS |
|---|-----------------|
| DESIGN REPORTS | None Available. |
| GEOLOGY REPORTS | None Available. |
| DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES | None Available |
| MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY } FIELD } | None Available. |
| POST-CONSTRUCTION SURVEYS OF DAM | None Available. |
| BORROW SOURCES | Unknown |

Sheet 3 of 4

| ITEM | REMARKS |
|---|--|
| MONITORING SYSTEMS | Monitored during large storm by John Brillman, property caretaker. |
| MODIFICATIONS | None known of. |
| HIGH POOL RECORDS | Maximum 6 inches above spillway crest according to present owner. |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS | None known of |
| PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS | None recorded |
| MAINTENANCE OPERATION RECORDS | None kept. |

Sheet 4 of 4

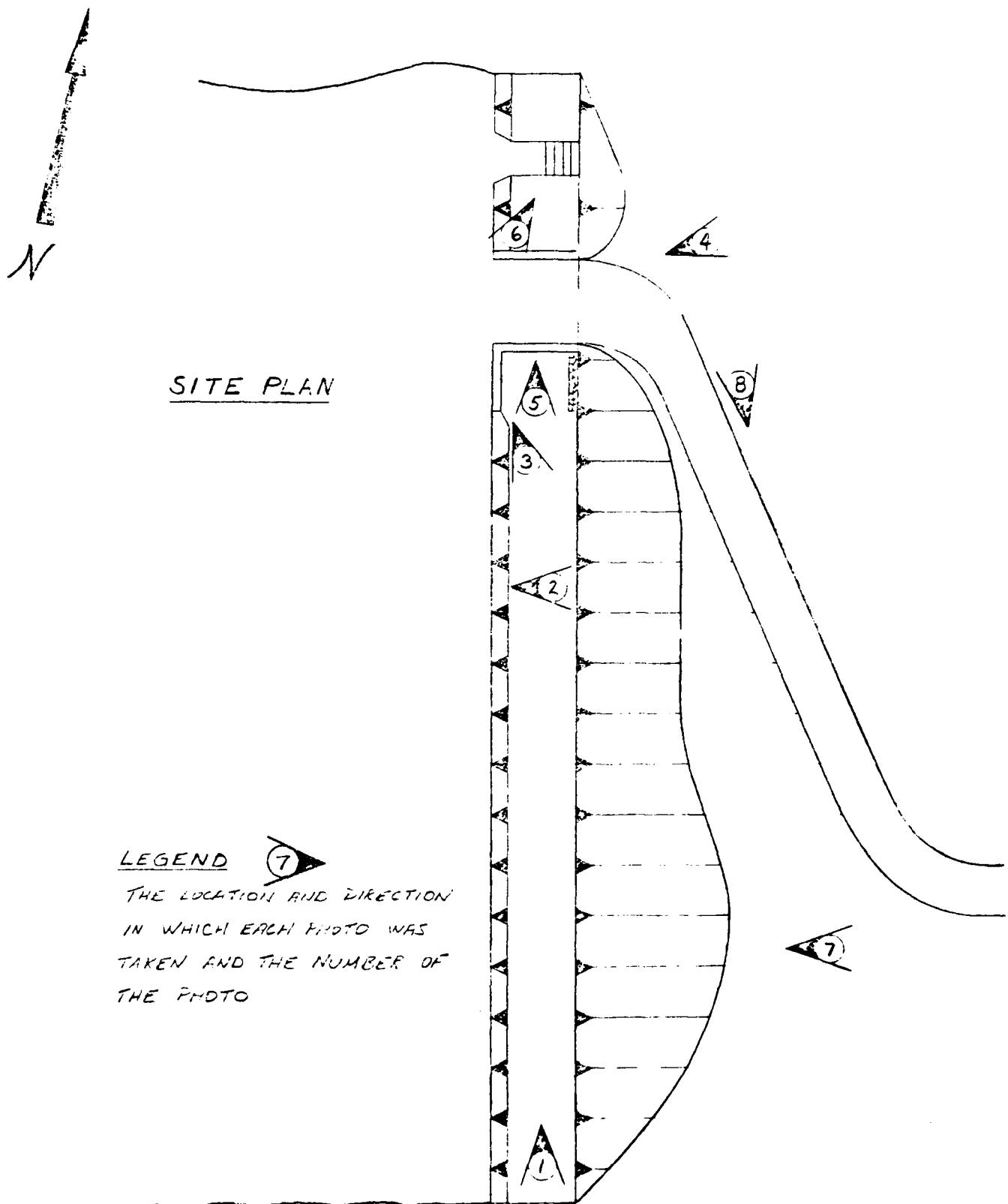
| ITEM | REMARKS |
|---------------------|---------------------|
| SPILLWAY PLAN | |
| } SECTIONS | Refer to Appendix E |
| } DETAILS | |
| OPERATING EQUIPMENT | |
| PLANS & DETAILS | None |
| MISCELLANEOUS | |

APPENDIX C
PHOTOGRAPHS

APPENDIX C
PHOTOGRAPH TABLE OF CONTENTS

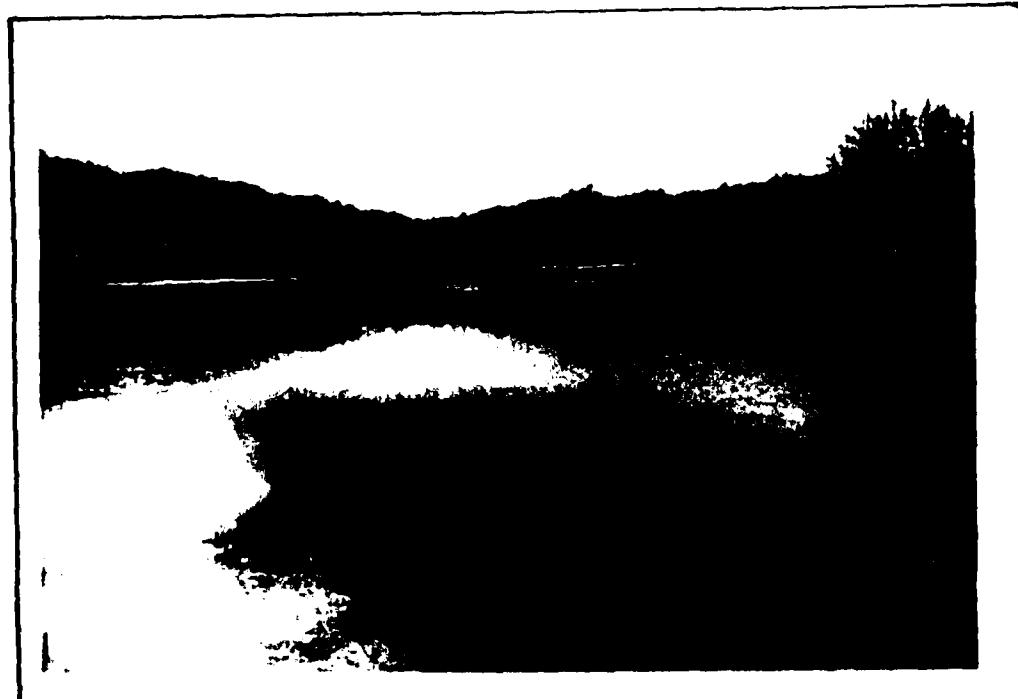
| | <u>Page No.</u> |
|--|-----------------|
| Site Plan | A |
| <u>PHOTOGRAPH</u> | |
| <u>No.</u> | |
| 1. View along top of dam from the right abutment. (12/19/80) | 1 |
| 2. View of the reservoir from the top of the dam. (12/19/80) | 1 |
| 3. Spillway and abutments near the left abutment. (12/19/80) | 2 |
| 4. Spillway and discharge channel looking upstream. (12/19/80) | 2 |
| 5. 2-foot deep hole adjacent to the right abutment of the spillway. (12/19/80) | 3 |
| 6. Wooden sluiceway structure with stoplogs. (12/19/80) | 3 |
| 7. Seepage at the downstream toe of the embankment near the right abutment. | 4 |
| 8. Typical channel condition downstream of the dam. (12/19/80) | 4 |
| 9. Potential damage area about 8,000 feet downstream of the dam on the north bank of Aquetong Creek. (12.19/80) | 5 |

| | | | | | | | | | |
|-----------|------------------|-------|---|----|-----|------|---------|--------|-----------|
| Submittal | INGHAM CREEK DAM | SHEET | A | BY | JFR | DATE | 2/12/81 | JOB NO | 18411-014 |
|-----------|------------------|-------|---|----|-----|------|---------|--------|-----------|





1. VIEW ALONG TOP OF DAM FROM THE RIGHT ABUTMENT. (12/19/80)



2. VIEW OF THE RESERVOIR FROM THE TOP OF THE DAM. (12/19/80)



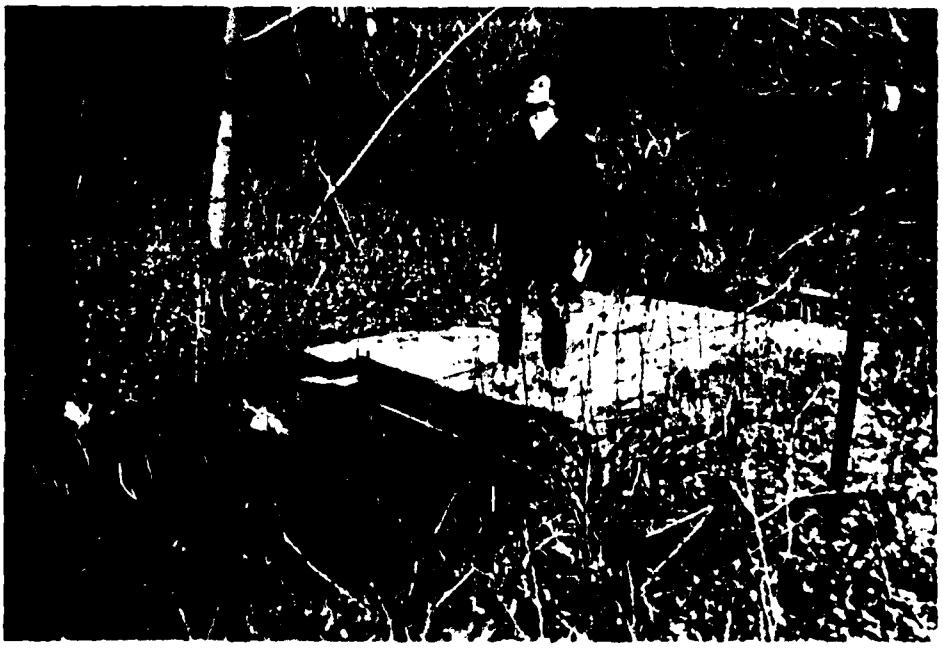
3. SPILLWAY AND ABUTMENTS NEAR THE LEFT ABUTMENT. (12/19/80)



4. SPILLWAY AND DISCHARGE CHANNEL LOOKING UPSTREAM. (12/19/80)



5. 2-FOOT DEEP HOLE ADJACENT TO THE RIGHT ABUTMENT OF THE SPILLWAY. (12/19/80)



6. WOODEN SLUICeway STRUCTURE WITH STOPLOGS. (12/19/80)



7. SEEPAGE AT THE DOWNSTREAM TOE OF THE EMBANKMENT NEAR THE RIGHT ABUTMENT. (12/19/80)



8. TYPICAL CHANNEL CONDITIONS DOWNSTREAM OF THE DAM.
(12/19/80)



9. POTENTIAL DAMAGE AREA ABOUT 8,000 FEET DOWNSTREAM OF
THE DAM ON THE NORTH BANK OF AQUETONG CREEK. (12/19/80)

APPENDIX D
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

INGHAM CREEK DAM
APPENDIX D
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

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| Checklist, Hydrologic and Hydraulic Engineering Data | 1 |
| HEC-1, Revised, Flood Hydrograph Package | 2 |
| Area-Elevation Data & SCS Lag Time | 3 |
| 100 Year Storm & Flood Development | 4 through 7 |
| Stage-Discharge Data | 8 |
| Stage-Discharge Curve & Stage-Storage Curve | 9 |
| HEC-1 Dam Safety Version, Non-Breach Computer Output | 10 through 12 |

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATADRAINAGE AREA CHARACTERISTICS: RURAL - FORESTEDELEVATION TOP NORMAL POOL (STORAGE CAPACITY): ELEV. 149.8 MSL (93 ACRE-FEET)ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/AELEVATION MAXIMUM DESIGN POOL: N/AELEVATION TOP DAM: ELEV. 150.8 MSL (LOW POINT TOP OF DAM)

SPILLWAY

a. Elevation ELEV. 149.8 MSLb. Type CONCRETE SLABc. Width 25 FEET @ UPSTREAM END & 21 FEET @ DOWNSTREAM ENDd. Length 25 FEETe. Location Spillover NEAR LEFT ABUTMENTf. Number and Type of Gates NONE

OUTLET WORKS:

a. Type SLUICeway STRUCTURE WITH WOODEN FLASHBOARDS, ~ 2 1/2' HIGHb. Location LEFT OF SPILLWAYc. Entrance invert ≈ ELEV. 148.4 MSLd. Exit invert ≈ ELEV. 148.4 MSLe. Emergency draindown facilities NONE

HYDROMETEOROLOGICAL GAGES:

a. Type NONE WITHIN WATERSHEDb. Location N/Ac. Records N/AMAXIMUM NON-DAMAGING DISCHARGE: NOT DETERMINED

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quadrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputted and flows are routed downstream to the damage center and a dam breach analysis is performed ¹

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out.

"High "hazard structures only



O'BRIEN & GERE

| SUBJECT | 3 | BY | DATE | JOB NO |
|------------|---|-----|---------|----------|
| INGHAM DAM | | JFR | 1/27/81 | 1841-014 |

18
3/9/81

HYDROLOGY CALCULATIONS

DRAINAGE AREA (PLANIMETERED FROM USGS QUAD SHEET): 0.39 SQ.MI.

AREA - ELEVATION DATA

ELEV.

AREA (ACRES)

150 (RES. W.S.E.)*

12.4

160

24.8

180

44.11

* RESERVOIR WATER SURFACE ELEVATION AT TIME OF INSPECTION WAS
ESTIMATED FROM USGS QUAD. SHEET.

SCS LAG TIME

AVG. BASIN SLOPE = $\Delta E.L.$

$$= \frac{320 - 150}{3000} = 0.06 \frac{\text{ft.}}{\text{ft.}}$$

$\nu = 0.62 \text{ ft/s}$ (SCS HANDBOOK, SEC. 4, HYDROLOGY)

$$T_c = \frac{3000}{0.62} = 4839 \text{ sec.} = 1.34 \text{ hrs. (cong.)}$$

$$L = 0.6 T_c = 0.6 (1.34) = 0.80 \text{ hrs. (lag)}$$

$$T_p = \frac{D}{2} + L = \frac{0.133 T_c}{2} + L$$

$$= \frac{0.133 (1.34)}{2} + 0.80$$

$$= 0.89 \text{ hrs. (peak)}$$



O'BRIEN & GERE

| | | | | | |
|---------|------------------|-------|-----|---------|--------------|
| SUBJECT | INGHAM CREEK DAM | SHEET | BY | DATE | JOB NO |
| | | 4 | JFR | 4-15-81 | 1841-014-111 |

ONE HUNDRED YEAR STORM DEVELOPMENT

RAINFALL FOR 100 YEAR RETURN *

| DURATION | RAINFALL |
|----------|----------|
| 30 MIN. | 2.4" |
| 1 HR. | 3.2" |
| 2 HR. | 3.9" |
| 3 HR. | 4.3" |
| 6 HR. | 5.2" |
| 12 HR. | 6.2" |
| 24 HR. | 7.2" |

* FROM TP-40, U.S. WEATHER BUREAU

THE FOLLOWING HYPOTHETICAL HYETOGRAPH WAS DEVELOPED USING THE SCS METHOD OF RAINFALL DISTRIBUTION. DATA FOR THE STORM WAS ACQUIRED FROM AN ACCUMULATED RAINFALL-DURATION CURVE. THE 24-HOUR MASS CURVE WAS DIVIDED INTO 15 MINUTE INTERVALS TO OBTAIN THE CORRESPONDING RAINFALL INCREMENTS.



O'BRIEN & GERE

SUBJECT

INGHAM CREEK DAM

SHEET
5BY
JFRDATE
4-15-81JOB NO
1841-014-111

100 YR. STORM DISTRIBUTION

TIME INTERVAL
(HOURS)

FROM

TO

RAINFALL
INCREMENT
(INCHES)NUMBER OF
INCREMENTS

| | | | |
|--------|--------|------|----|
| 0 | 4 3/4 | .02 | 19 |
| 4 3/4 | 7 1/4 | .03 | 10 |
| 7 1/4 | 8 | .04 | 3 |
| 8 | 9 | .05 | 4 |
| 9 | 9 1/2 | .06 | 2 |
| 9 1/2 | 10 | .07 | 2 |
| 10 | 10 1/2 | .08 | 2 |
| 10 1/2 | 10 3/4 | .10 | 1 |
| 10 3/4 | 11 | .12 | 1 |
| 11 | 11 1/4 | .14 | 1 |
| 11 1/4 | 11 1/2 | .20 | 1 |
| 11 1/2 | 11 3/4 | .34 | 1 |
| 11 3/4 | 12 | .90 | 1 |
| 12 | 12 1/4 | 1.50 | 1 |
| 12 1/4 | 12 1/2 | .41 | 1 |
| 12 1/2 | 12 3/4 | .20 | 1 |
| 12 3/4 | 13 | .16 | 1 |
| 13 | 13 1/4 | .13 | 1 |
| 13 1/4 | 13 1/2 | .10 | 1 |
| 13 1/2 | 13 3/4 | .09 | 1 |
| 13 3/4 | 14 1/4 | .08 | 2 |
| 14 1/4 | 14 3/4 | .07 | 2 |
| 14 3/4 | 15 1/4 | .06 | 2 |
| 15 1/4 | 16 | .05 | 3 |
| 16 | 17 | .04 | 4 |
| 17 | 19 1/2 | .03 | 10 |
| 19 1/2 | 24 | .02 | 18 |

7.20"96



O'BRIEN & GERE

INGHAM DAM

6

JFK

4-21-81

JOB NO

1841-014

PEAK INFLOW, Q_{100} , FOR 100 YR. FLOOD (CONT'D.)

Reference: Regional Frequency Study, Upper Delaware and Hudson River Basins, New York District, C.O.E., Nov. 1974.

$$\log(Q_m) = C_m + 0.87 \log(A)$$

$$S = C_s - 0.05 \log(A)$$

$$\log(Q_{100}) = \log(Q_m) + KS$$

$$C_m = 2.10 \quad (\text{Fig. 2})$$

$$C_s = 0.334 \quad (\text{Fig. 3})$$

$$g = +0.4 \quad \therefore K = 2.615$$

$$\log(Q_m) = 2.10 + 0.87 \log(.39) = 1.744$$

$$S = 0.334 - 0.05 \log(.39) = 0.354$$

$$\log(Q_{100}) = 1.744 + 2.615 (.354) = 2.670$$

$$Q_{100} = \underline{\underline{468 \text{ cfs}}}$$

SCS Curve Number is determined by trial & error using HEC-1-UB, to be 78.

$$Q_{\text{PEAK}} = 468$$

ECT

INGHAM DAM

SHEET

7

BY JFR

DATE

1-27-81

JOB NO

1841-014

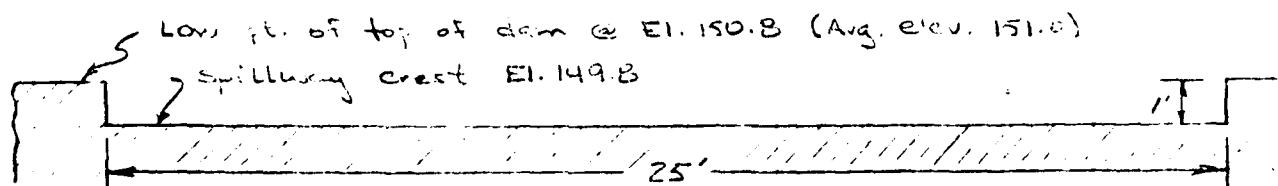
STAGE - DISCHARGE DATA

$$\text{SPILLWAY: } Q_s = C L_s H_s^{3/2}$$

$C = 3.0$ (concrete, 25' wide on 10% slope)
 $L_s = 25$ FEET.

$$\text{TOP OF DAM: } Q_d = C L_d H_d^{3/2}$$

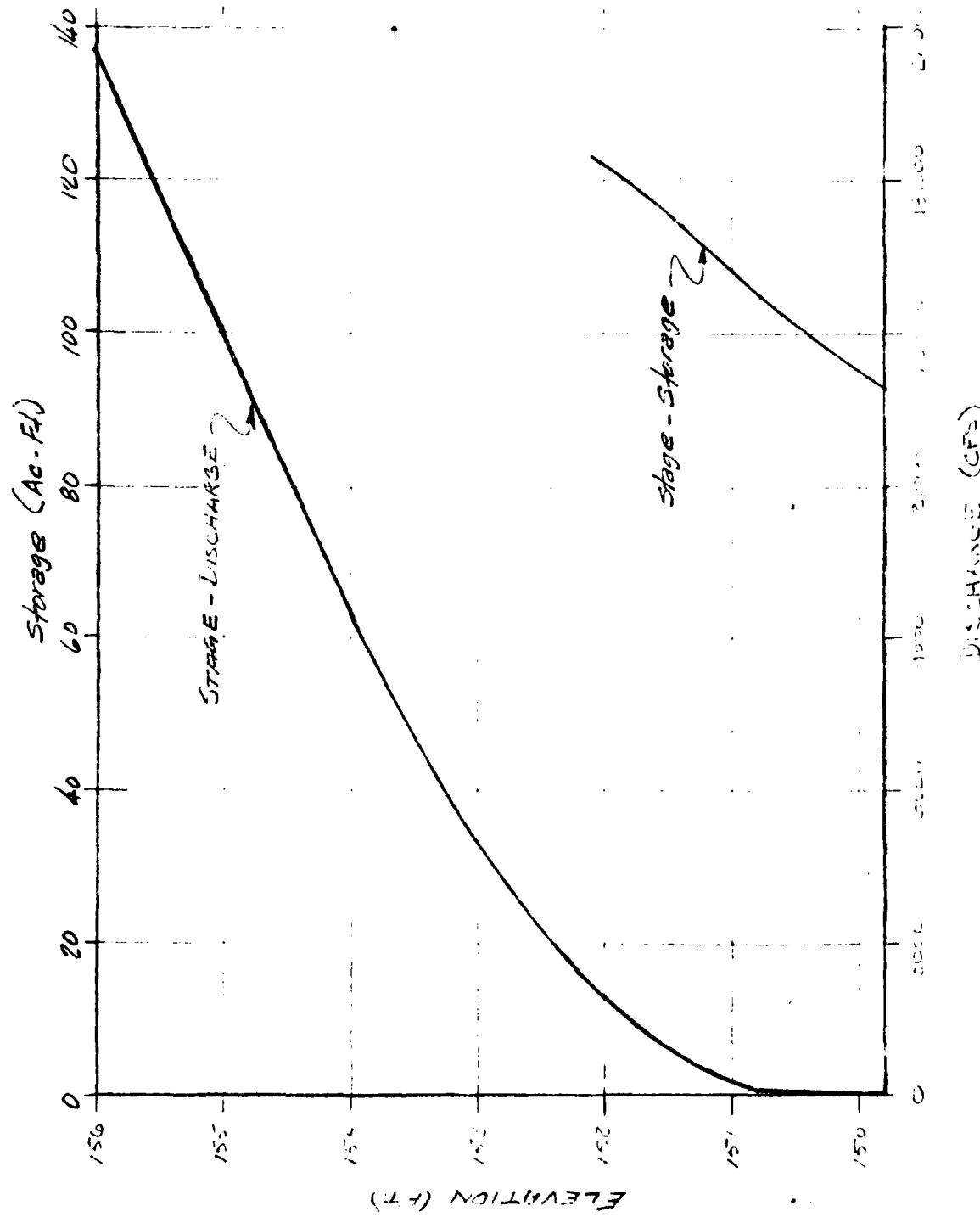
$C = 2.7$ (Top of dam with brush & trees)
 L_d is measured at 5/6 the actual width
 above the dam crest. Alignment slopes
 assumed 3.5 H:1V (Refer to 14-46, NEI 14, SC)



| W.S.E. | H_s (FT) | Q_s^* (CFS) | H_d^{**} (FT) | L_d (FT) | Q_d^* (CFS) | Q_{TOTAL} (CFS) |
|--------|---------------|------------------|--------------------|---------------|------------------|----------------------|
| 149.8 | 0 | 0 | | | | 0 |
| 150.3 | 1.5 | 30 | | | | 30 |
| 150.8 | 1.0 | 80 | 0 | | | 80 |
| 152.2 | 2.4 | 280 | 1.2 | 608 | 2160 | 2440 |
| 154.0 | 4.2 | 650 | 3.0 | 629 | 3820 | 5470 |
| 156.0 | 6.2 | 1160 | 5.0 | 641 | 19350 | 20510 |
| 158.0 | 8.2 | 1760 | 7.0 | 653 | 32650 | 34410 |
| 160.0 | 10.2 | 2440 | 9.0 | 664 | 48410 | 50850 |

* To nearest 10 cfs.

** Measured above elev. 151.0 (avg. top of dam elev.)



SUB-AREA RUNOFF COMPUTATION

• 100 •

| NAME | EDUC | RELIG | ETHNIC | SEX | JEFF | ANNE | 1STAGE | IAUTC |
|--------------|------|------------|--------|-----|------|------|--------|-------|
| WHITE, JAMES | 8 | PROTESTANT | WHITE | M | 0.35 | 0.01 | 0 | 0 |
| WHITE, JAMES | 8 | PROTESTANT | WHITE | M | 0.35 | 0.01 | 0 | 0 |
| WHITE, JAMES | 8 | PROTESTANT | WHITE | M | 0.35 | 0.01 | 0 | 0 |

| STRIKE | BL TIME | BL TIME | BL TIME | BL TIME | BL TIME | BL TIME | BL TIME | BL TIME |
|-------------|---------|-----------|---------|----------|---------|---------|---------|---------|
| 0.00 | 0.00 | 2.00 | 0.00 | 0.00 | 2.00 | -1.00 | -25.00 | 0.00 |
| DEFINE NO = | -70.00 | WEIGHTS = | -2.00 | EFF NO = | 25.00 | = | 76.00 | |

TC = 0.05 - AG = 0.05 RTDR = 2.00

| | | | | | | |
|-------|-------|---------|---------|----------|----------|----------|
| 30.00 | 80.00 | 2440.00 | 9470.00 | 26510.00 | 34410.00 | 36850.00 |
| 3. | 12. | 7 | 44. | | | |
| 6. | 54. | 54. | 7000. | | | |
| | | | | | | |

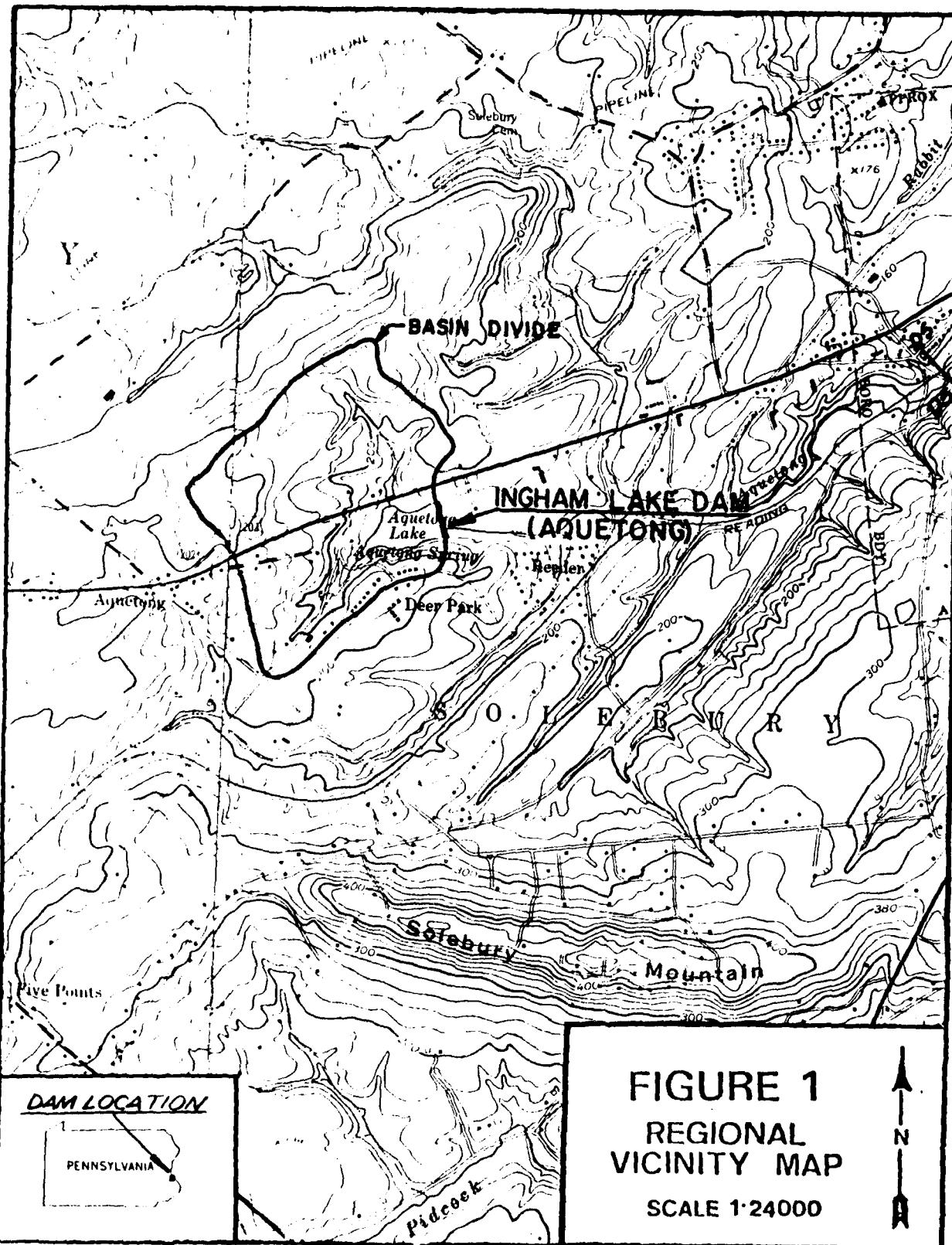
54

APPENDIX E
REGIONAL VICINITY MAP
&
DRAWINGS

INGHAM CREEK DAM
APPENDIX E
REGIONAL VICINITY MAP & DRAWINGS

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|--|--------------|
| Regional Vicinity Map, Figure 1 | 1 |
| Plan of Dam & Reservoir from 1893 Survey | 2 |
| Site Plan | 3 |
| Profile Along Centerline of Dam Looking Downstream | 4 |
| Typical Dam Section & Typical Spillway Section | 5 |



Subject:

Ingham Lake (Aquetong) Dam

544

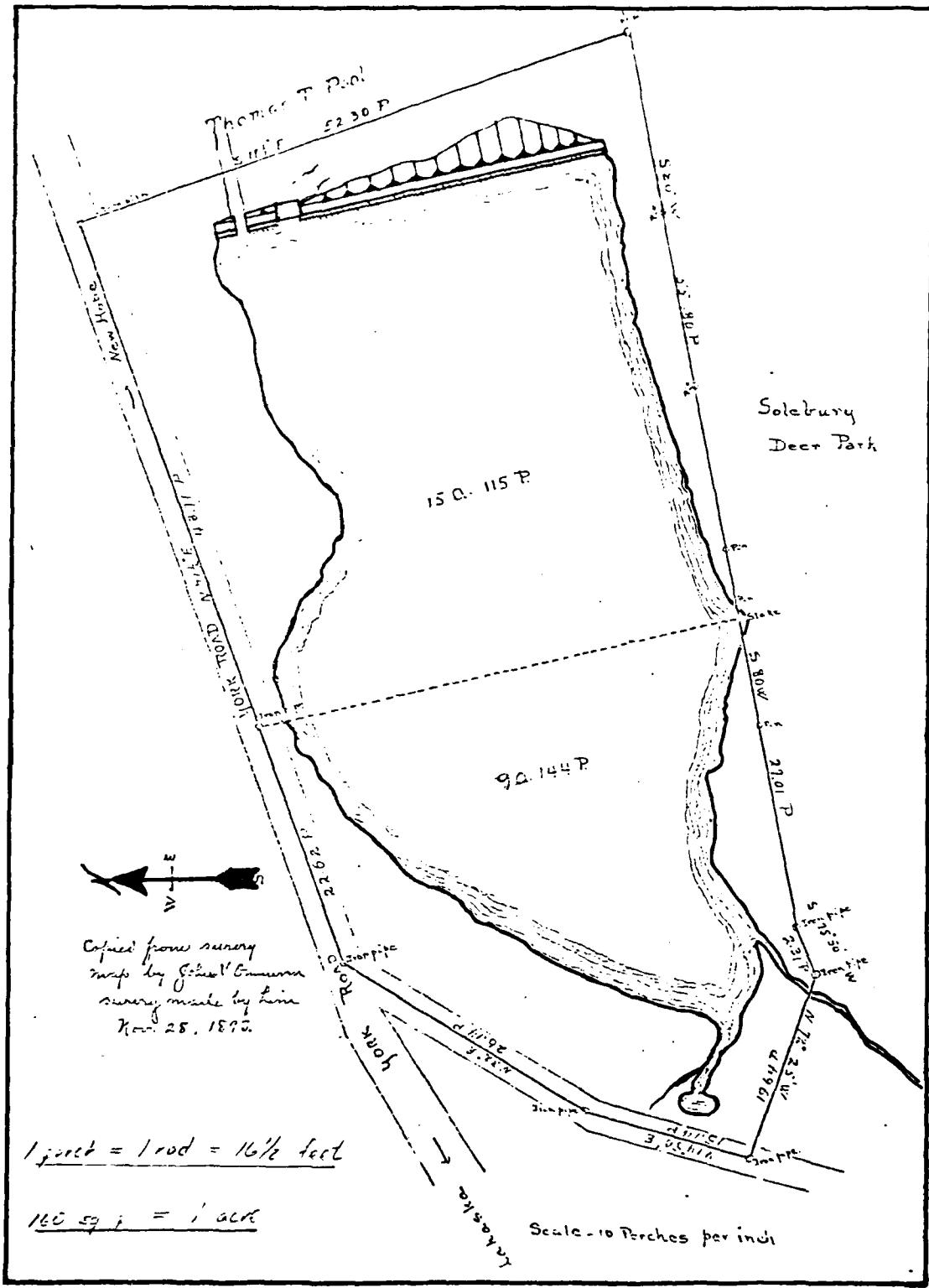
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DATE:

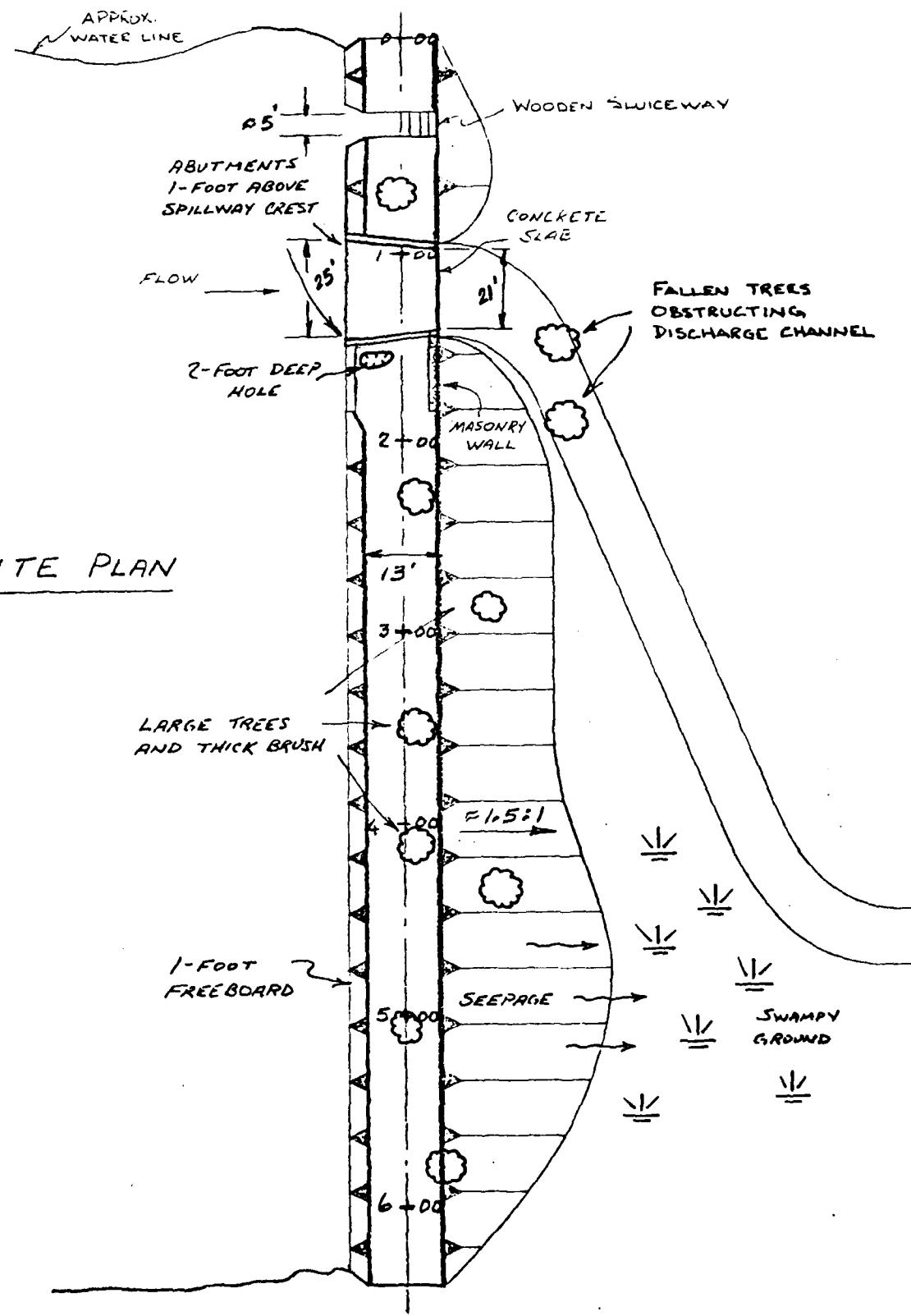
JOB NO

1841-014

Plan of Dam & Reservoir from 1893 Survey



SITE PLAN





**O'BRIEN & GERE
ENGINEERS, INC.**

SUSTAIN

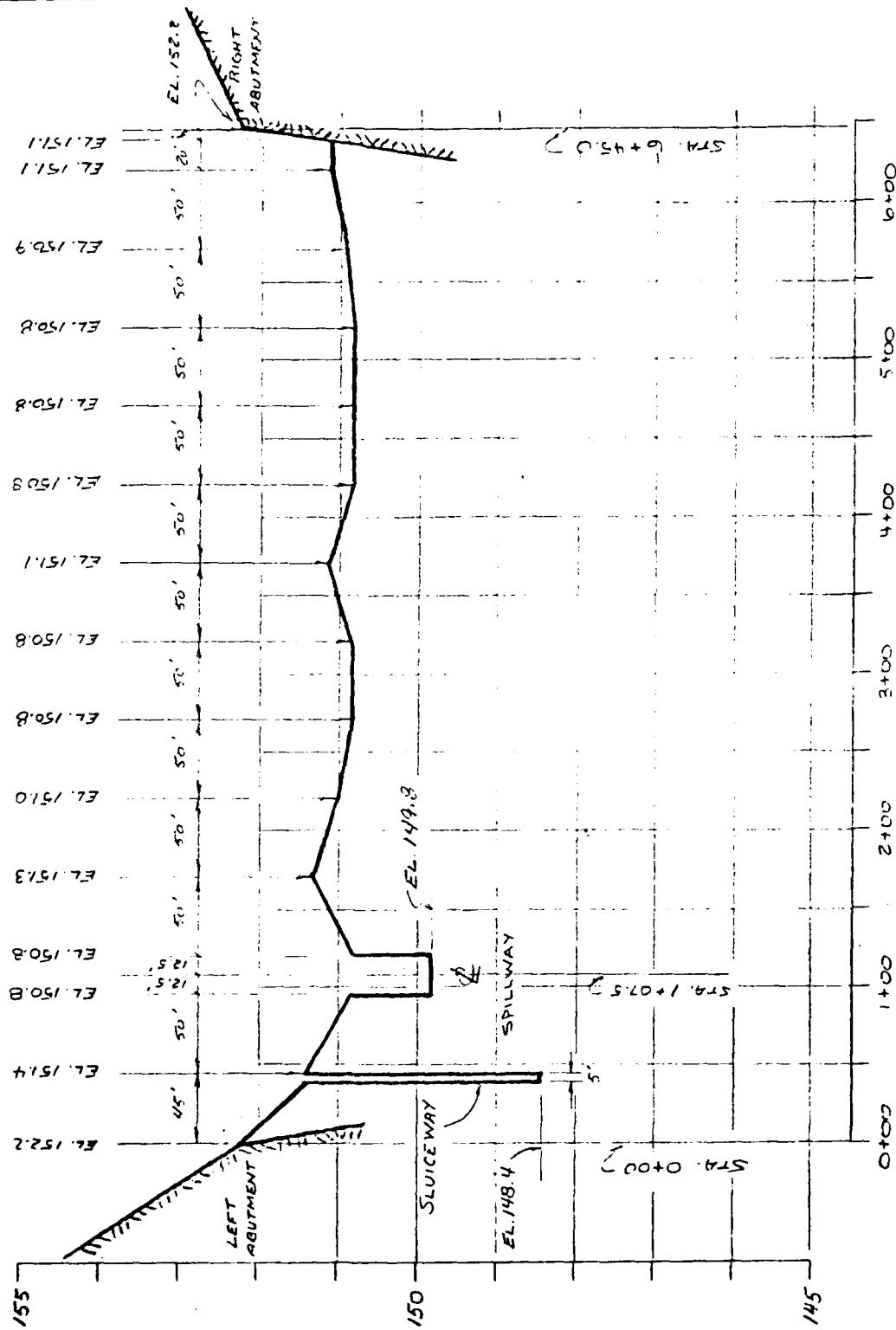
INGHAM LANT

SHEET

BY
JFK

DATE
1/28/31

JOB NO
18-4



PROFILE ALONG THE CROWN OF THE DAM LOOKING DOWNSTREAM

SUBJECT

INGHAM CREEK DAM

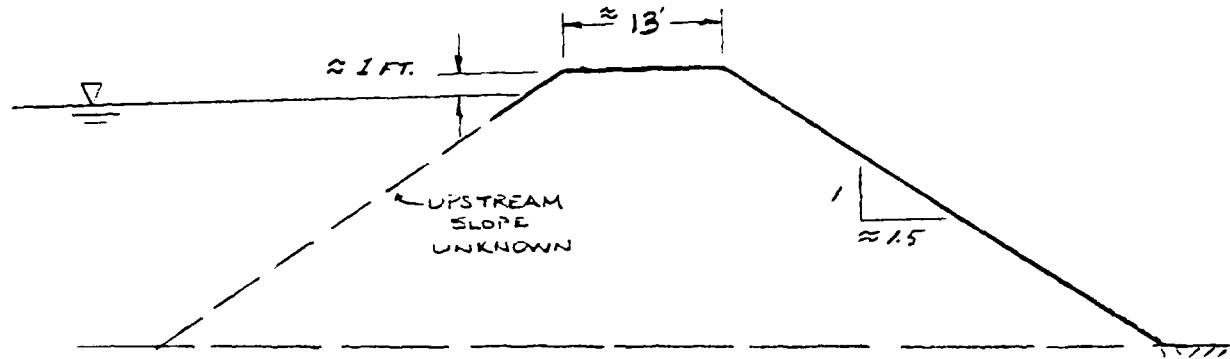
SHEET
5

B-
WFR

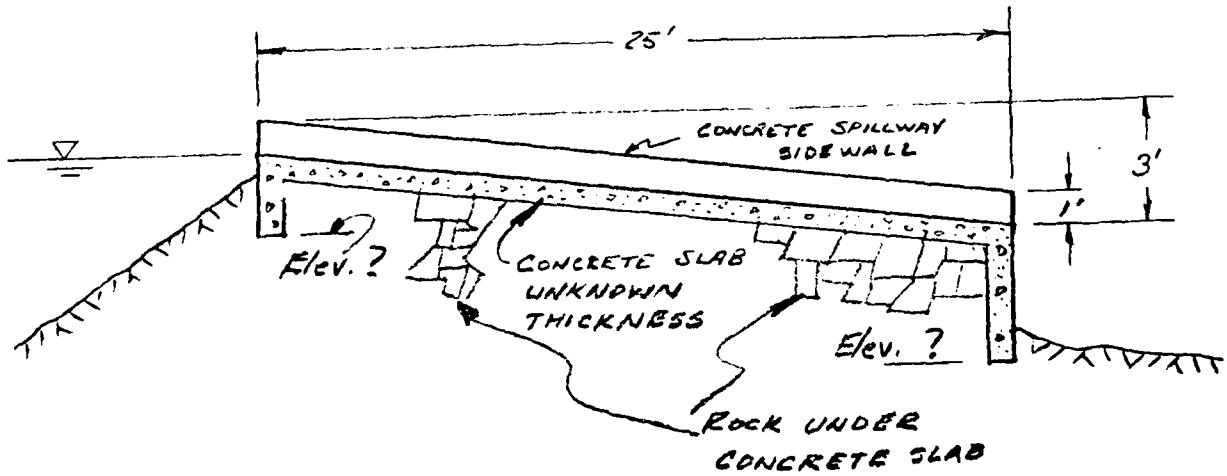
DATE
3/2/81

JOB NO
IE-1-014

TYPICAL DAM SECTION



TYPICAL SPILLWAY SECTION



APPENDIX F
GEOLOGY

SITE GEOLOGY

INGHAM LAKE

Ingham Lake Dam is located in the Lowland section of the Piedmont Physiographic Province. As shown in Figure 1, the damsite and surrounding region is underlain by Brunswick Lithofacies of the Triassic age. The Brunswick Lithofacies are lithologically the most uniform of the three major sedimentary units of the Newark Group in Bucks County. The rock is a weak bright-red argillaceous shale that readily crumbles into thin flakes or ragged fragments. Bedding is wavy and irregular, ripple marks are found at many places and mud cracks are common. The Brunswick Lithofacies are much more easily eroded than the underlying Lockatong agrillite or the intruding diabase. It, therefore, forms a low, gently rolling terrane with shallow valleys and low ridges parallel to the strike of the beds.

The apparently inactive Furlong fault is located about 0.25 miles west of the dam and is thought to be associated with the Triassic uplift of the Appalachian Mountains.

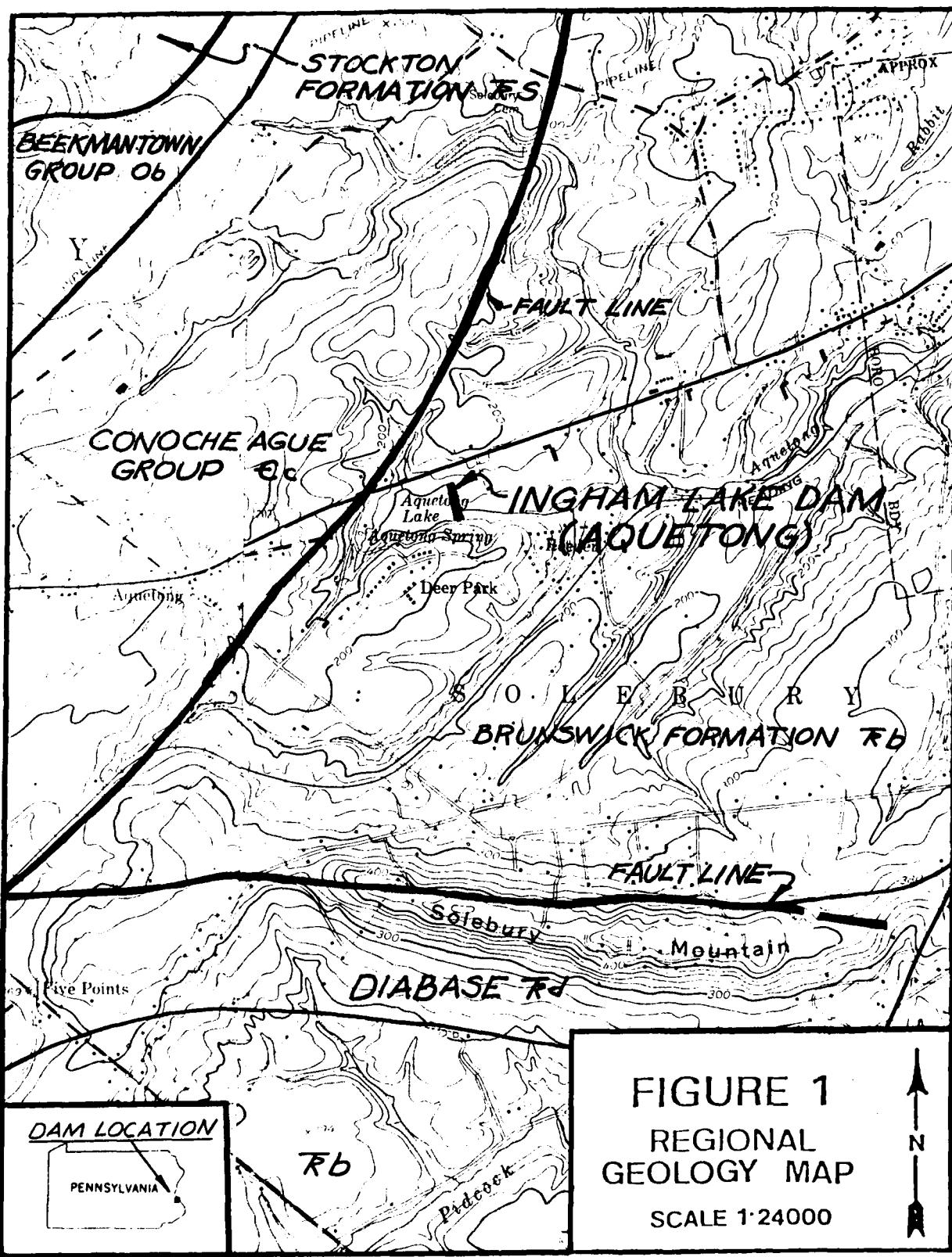


FIGURE 1
REGIONAL
GEOLOGY MAP
SCALE 1:24000

DATE:
TIME